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CERTIFICATION

I, Masahiko OHI, of Eishin Bldg., 6-1, Kanda Ogawa-machi 3-chome, Chiyoda-ku, Tokyo 101-0052, Japan, hereby certify that I am the translator of the application for patent filed in United States of America on the 11th day of March, 2004 with Serial No. 10/796982, and certify that the following is a true and correct translation to the best of my knowledge and belief.



Masahiko OHI

Dated the 9th day of July, 2004



[Document Name] · SPECIFICATION

[Title of Invention] GELLING AGENT AND PRODUCTION METHOD  
THEREOF

[Technical Field to which the Invention belongs]

5 [0001]

The present invention relates to a gelling agent, which is mixed with an organic solvent or a liquid crystal compound to form a gelling mixture, and a production method thereof.

10 [Prior art]

[0002]

In recent years, those composed of self-organizing low molecules that the molecules gather in a fibrous form by intermolecular interaction to form a fibrous molecular 15 aggregate have attracted attention as gelling agents.

Such a gelling agent is expected as, for example, a material for forming physical gel. As physical gel using a gelling agent, has been proposed, for example, a liquid crystal composition composed of the gelling agent and a 20 liquid crystal compound (see, for example, Japanese Patent Reference 1.).

[Patent Reference 1] Japanese patent application No. 2002-4462

[0003]

25 However, as the gelling agent, no gelling agent composed of self-organizing low molecules having a molecular structure that a carbazole component has been

introduced as a functional component has been known.

[Disclosure of the Invention]

[Problems that the Invention is to solve]

[0004]

5        The present invention has been completed as a result of repeated investigations of self-organizing low molecules, which form fibrous molecular aggregates, and has as its first object the provision of a novel gelling agent having a molecular structure that a carbazole 10 component has been introduced into an isoleucine derivative.

A second object of the present invention is to provide a method for producing a novel gelling agent.

[Means of solving the problems]

15        [0005]

According to the present invention, there is thus provided a gelling agent composed of an isoleucine derivative having a carbazolyl group.

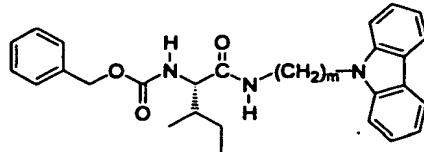
[0006]

20        The gelling agent according to the present invention may preferably be composed of an isoleucine derivative having a carbazolyl group and represented by the following general formula (1).

[0007]

25        [Chemical Formula 1]

General formula (1) :



[0008]

(In the formula, m is an integer of at least 6.)

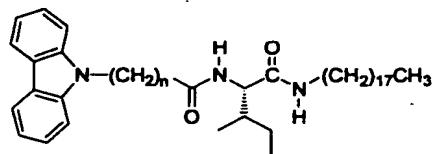
5 [0009]

The gelling agent according to the present invention may also be composed of an isoleucine derivative having a carbazolyl group and represented by the following general formula (2).

10 [0010]

[Chemical Formula 2]

General formula (2) :



[0011]

15 (In the formula, n is an integer of at least 1.)

[0012]

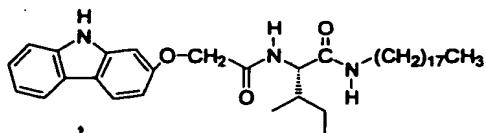
Further, the gelling agent according to the present invention may be composed of an isoleucine derivative having a carbazolyl group and represented by the

following formula (1).

[0013]

[Chemical Formula 3]

Formula (1):



5

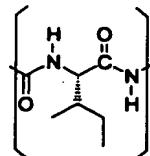
[0014]

According to the present invention, there is provided a method for producing a gelling agent, which comprises reacting an isoleucine derivative having a skeleton represented by the following formula (2) with a compound having a carbazolyl group in the presence of dichloromethane and 1-ethyl-3-(3-dimethylaminopropyl)-carbodiimide hydrochloride to obtain an isoleucine derivative having a carbazolyl group.

15 [0015]

[Chemical Formula 4]

Formula (2):



[Effects of Invention]

20 [0016]

The gelling agents according to the present

invention are gelling agents composed of an isoleucine derivative having a molecular structure that a carbazole component derived from a carbazole compound having excellent photoconductivity and light refraction property 5 has been introduced into an isoleucine derivative.

Since such a gelling agent has excellent gel-forming ability, and a functional component composed of the carbazole component is introduced into it, there is a possibility that a fibrous molecular aggregate having 10 photo-electronic functions may be formed.

[0017]

According to the production method of a gelling agent of the present invention, a novel gelling agent with a carbazole component introduced into an isoleucine derivative can be prepared. 15

[Best Mode to Practice the Invention]

[0018]

The present invention will hereinafter be described in detail.

20 Specific preferable examples of the gelling agent according to the present invention include that composed of an isoleucine derivative (hereinafter also referred to as "carbazolyl group containing isoleucine derivative (1)" having the carbazolyl group and represented by the 25 above general formula (1), that composed of an isoleucine derivative (hereinafter also referred to as "carbazolyl group containing isoleucine derivative (2)" having the

carbazolyl group and represented by the above general formula (2), and that composed of an isoleucine derivative (hereinafter also referred to as "carbazolyl group containing isoleucine derivative (3)" having the 5 carbazolyl group and represented by the above formula (1).

In the specification of the present invention, the carbazolyl group may have any substituent group.

[0019]

In the general formula (1), m is an integer of at 10 least 6.

The carbazolyl group containing isoleucine derivative (1) has a lower melting point as m in the general formula (1) becomes greater. A gelling mixture obtained by mixing the gelling agent composed of the 15 carbazolyl group containing isoleucine derivative (1) has a lower gel-sol transition temperature as the melting point of the carbazolyl group containing isoleucine derivative (1) that is a component of the mixture becomes lower.

20 [0020]

In the general formula (2), n is an integer of at least 1.

The carbazolyl group containing isoleucine derivative (2) has a lower melting point as n in the 25 general formula (2) becomes greater. A gelling mixture obtained by mixing the gelling agent composed of the carbazolyl group containing isoleucine derivative (2) has

a lower gel-sol transition temperature as the melting point of the carbazolyl group containing isoleucine derivative (2) that is a component of the mixture becomes lower.

5 [0021]

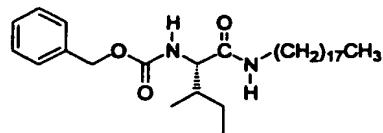
The gelling agents composed of the carbazolyl group containing isoleucine derivative (1), the carbazolyl group containing isoleucine derivative (2) and the carbazolyl group containing isoleucine derivative (3) are 10 preferred as the gelling agents according to the present invention. However, the gelling agents according to the present invention are not limited to these, and it is only necessary to consist of an isoleucine derivative (hereinafter also referred to as "carbazolyl group 15 containing isoleucine derivative") having the carbazolyl group.

Specifically, the carbazolyl group containing isoleucine derivative constituting the gelling agent according to the present invention is only required to 20 have a molecular structure that at least one of a benzyloxy group and an alkyl group at a terminal of an isoleucine derivative represented by the following formula (3) is substituted by a carbazolyl group.

[0022]

25 [Chemical Formula 5]

Formula (3):



[0023]

The gelling agent composed of such a carbazolyl  
5 group containing isoleucine derivative as described above  
can be prepared by reacting an isoleucine derivative  
(hereinafter also referred to as "raw isoleucine  
derivative") having a skeleton represented by the above  
formula (2) with a compound (hereinafter also referred to  
10 as "raw carbazole derivative") having a carbazolyl group  
in the presence of dichloromethane and 1-ethyl-3-(3-  
dimethyl-aminopropyl)carbodiimide hydrochloride.

[0024]

In this reaction, the number of moles of the raw  
15 isoleucine derivative and the number of moles of the raw  
carbazole derivative are substantially equivalent to each  
other and preferably reside in an equimolar relation.

[0025]

The amount of dichloromethane used is preferably  
20 5,000 to 10,000 parts by mass per 100 parts by mass of  
the raw isoleucine derivative.

The amount of 1-ethyl-3-(3-dimethylaminopropyl)-  
carbodiimide hydrochloride used is preferably 120 to 200  
parts by mass per 100 parts by mass of the raw isoleucine

derivative.

[0026]

The reaction temperature is, for example, 20 to 30°C, and the reaction time is, for example, 3 to 6 hours.

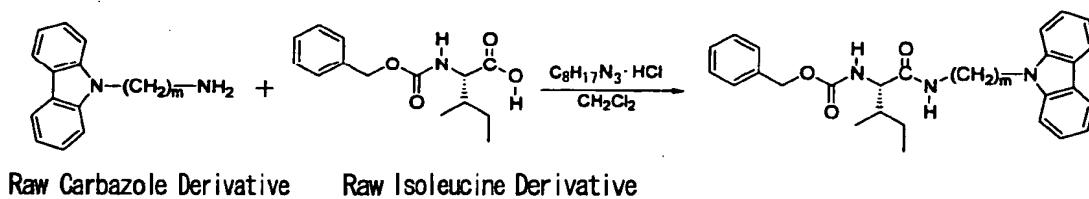
5 [0027]

Synthesis process for forming the carbazolyl group containing isoleucine derivative (1) is shown in the following reaction scheme (1). Synthesis process for forming the carbazolyl group containing isoleucine 10 derivative (2) is shown in the following reaction scheme (2). Synthesis process for forming the carbazolyl group containing isoleucine derivative (3) is shown in the following reaction scheme (3).

[0028]

15 [Chemical Formula 6]

Reaction scheme (1):



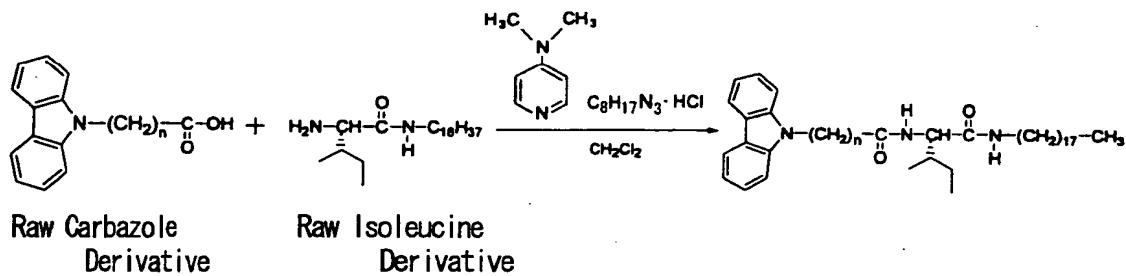
[0029]

(In the formula, m is an integer of at least 6.)

[0030]

[Chemical Formula 7]

Reaction scheme (2) :



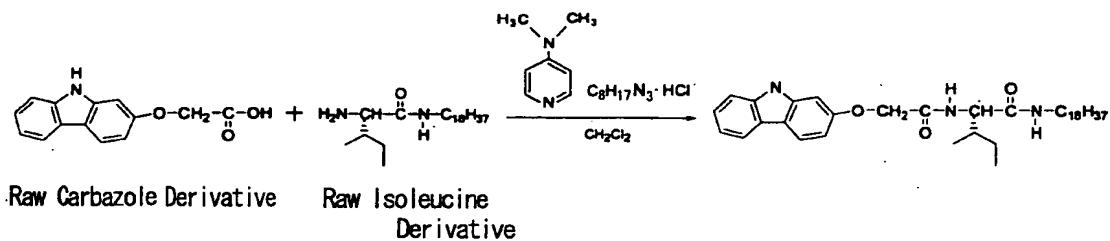
5 [0031]

(In the formula, n is an integer of at least 1.)

[0032]

[Chemical Formula 8]

Reaction scheme (3) :



10

[0033]

It is preferred that 4-(*N,N*-dimethylamino)pyridine be present in reaction systems for forming the carbazolyl group containing isoleucine derivative (2) and the carbazolyl group containing isoleucine derivative (3).  
15 The reason for it is that a high yield can be

achieved.

4-(N,N-Dimethylamino)pyridine may also be used in a reaction system for forming the carbazolyl group containing isoleucine derivative (1).

5 [0034]

The gelling agents according to the present invention may also be prepared by any other method than the production method described above.

[0035]

10 Such a gelling agent as described above has good gel-forming ability for organic solvents or liquid crystal compounds and has a possibility that a fibrous molecular aggregate having photo-electronic functions such as photoconductivity derived from the carbazole 15 component may be formed.

Such a gelling agent may be suitably used as a material forming physical gel, and a gelling mixture using the gelling agent has a possibility of being suitably usable as a liquid crystal display device.

20 [0036]

Examples of the organic solvents include ethyl acetate, ethanol, methanol, acetone, carbon tetrachloride, chloroform, benzene, toluene, tetrahydrofuran and N,N-dimethylformamide.

25 Examples of the liquid crystal compounds include 4-pentyl-4'-cyanobiphenyl, 4-octyl-4'-cyanobiphenyl and 4-octyloxy-4'-cyanobiphenyl.

[0037]

[Example]

The present invention will hereinafter be described by the following examples. However, the present 5 invention is not limited to these examples.

[Example 1]

[0038]

(Preparation Example 1 of gelling agent)

With 1.40 g of a compound, in which m in the raw 10 carbazole derivative in the reaction scheme (1) is 12, were mixed 1.06 g of Z-L-isoleucine, 52.8 g of dichloromethane and 0.920 g of 1-ethyl-3-(3-dimethyl-aminopropyl) carbodiimide hydrochloride, and this system was subjected to a reaction at 25°C for 3 hours, thereby 15 obtaining a reaction product at a yield of 65%.

As the result of the following elemental analysis and NMR measurement (solvent: deuterated chloroform), the resultant reaction product was identified as a carbazolyl group containing isoleucine derivative (hereinafter also 20 referred to as "Gelling Agent (1)", in which m in the general formula (1) is 12.

Gelling Agent (1) had a melting point of 106°C.

[0039]

(Result of elemental analysis)

25 Calculated: C 76.34, H 8.60, N 7.03 %

Found: C 76.07, H 8.37, N 7.41 %

[0040]

(Result of NMR measurement)

CDCl<sub>3</sub>, δ 8.11-8.10 (d, J=7.6Hz, 2H), 7.48-7.21 (m, 11H),  
5.76 (m, 1H), 5.30 (m, 1H), 5.10 (s, 2H), 4.32-  
4.28 (t, J=7.2Hz, 2H), 3.94-3.90 (t, J=6.8Hz, 1H), 3.21 (m, 2H),  
5 1.89-1.85 (m, 4H), 1.47-1.23 (m, 21H), 0.93-0.88 (m, 6H)

[0041]

(Confirmation of gel-forming ability of Gelling Agent  
(1))

With respect to Gelling Agent (1), the gel-forming  
10 ability for various organic solvents and liquid crystal  
compounds was investigated. As a result, Gelling Agent  
(1) exhibited good gel-forming ability for ethyl acetate,  
acetone, carbon tetrachloride, benzene and toluene that  
are organic solvents and for 4-pentyl-4'-cyanobiphenyl  
15 and 4-octyl-4'-cyanobiphenyl that are liquid crystal  
compounds.

[0042]

Gelling mixtures composed of Gelling Agent (1) and  
each of the organic solvents and liquid crystal compounds,  
20 for which Gelling Agent (1) exhibited the gel-forming  
ability, were observed through a scanning electron  
microscope respectively. As a result, it was confirmed  
that a fibrous molecular aggregate derived from Gelling  
Agent (1) having a network structure that fine and long  
25 fibers were entangled with each other is formed in an  
isotropic phase of each of the organic solvents and  
liquid crystal compounds forming the respective gelling

mixtures.

[0043]

(Confirmation of properties of gelling mixture used  
Gelling Agent (1))

5 The sol-gel transition temperature of a gelling mixture obtained by mixing 3 % by mass of Gelling Agent (1) with 4-octyl-4'-cyanobiphenyl, that is a liquid crystal compound, was measured and found to be 15°C.

[0044]

10 A formed state of a fibrous molecular aggregate in a smectic A phase obtained by adding 1 to 3 % by mass of Gelling Agent (1) to 4-octyl-4'-cyanobiphenyl, that is a liquid crystal compound, and orientating it in one direction was observed through a scanning electron microscope and a polarizing microscope. As a result, it was confirmed that fibers grow predominantly in a direction parallel to the orientation direction of the liquid crystal molecules.

[0045]

20 A gelling mixture obtained by adding 10 % by mass of Gelling Agent (1) to 4-octyl-4'-cyanobiphenyl was enclosed into a cell having a thickness of 5  $\mu\text{m}$  and formed by 2 glass sheets to measure an ultraviolet-visible absorption spectrum in a temperature range of 25 from 25 to 80°C. As a result, a peak appeared at 350 nm in a gel state shifted to 347 nm in a sol state. The shift of the peak in this spectrum is considered to be

attributable to the fact that carbazolyl groups in the fibrous molecular aggregate are stacked. The result is illustrated in Fig. 1.

In Fig. 1, the ultraviolet-visible absorption spectrum in the gel state is shown by a solid line, and the ultraviolet-visible absorption spectrum in the sol state is shown by a broken line.

[Example 2]

[0046]

10 (Synthesis Example 2 of gelling agent)

With 1.06 g of a compound, in which m in the raw carbazole derivative in the reaction scheme (1) is 6, were mixed 1.12 g of Z-L-isoleucine, 39.6 g of dichloromethane and 1.60 g of 1-ethyl-3-(3-dimethyl-15 aminopropyl) carbodiimide hydrochloride, and this system was subjected to a reaction at 25°C for 12 hours, thereby obtaining a reaction product at a yield of 44%.

As the result of the following elemental analysis and NMR measurement (solvent: deuterated chloroform), the 20 resultant reaction product was identified as a carbazolyl group containing isoleucine derivative (hereinafter also referred to as "Gelling Agent (2)"), in which m in the general formula (1) is 6.

Gelling Agent (2) had a melting point of 172°C.

25 [0047]

(Result of elemental analysis)

Calculated: C 74.82, H 7.65, N 8.18 %

Found: C 74.88, H 8.04, N 8.48 %

[0048]

(Result of NMR measurement)

CDCl<sub>3</sub>, δ 8.13-8.11 (d, J=7.6Hz, 1H), 8.11-8.10 (d, J=6.8Hz, 1H),  
5 7.50-7.21 (m, 11H), 5.77-5.76 (m, 1H), 5.29-5.27 (m, 1H),  
5.09 (s, 2H), 4.31-4.29 (t, J=7.6Hz, 2H), 3.93-3.88 (m, 1H),  
3.26-3.16 (m, 2H), 1.87 (m, 4H), 1.45-1.39 (m, 7H), 0.93-  
0.88 (m, 6H)

[0049]

10 (Confirmation of gel-forming ability of Gelling Agent  
(2))

With respect to Gelling Agent (2), the gel-forming  
ability for various organic solvents and liquid crystal  
compounds was investigated. As a result, Gelling Agent  
15 (2) exhibited good gel-forming ability for carbon  
tetrachloride and benzene that are organic solvents.

[0050]

Gelling mixtures composed of Gelling Agent (2) and  
each of the organic solvents, for which Gelling Agent (2)  
20 exhibited the gel-forming ability, were observed through  
a scanning electron microscope respectively. As a result,  
it was confirmed that a fibrous molecular aggregate  
derived from Gelling Agent (2) having a network structure  
that fine and long fibers were entangled with each other  
25 is formed in an isotropic phase of each of the organic  
solvents forming the respective gelling mixtures.

[Example 3]

[0051]

(Synthesis Example 3 of gelling agent)

With 0.502 g of a compound, in which n in the raw carbazole derivative in the reaction scheme (2) is 6, 5 were mixed 0.661 g of a compound indicated as the raw isoleucine derivative in the reaction scheme (2), 53.1 g of dichloromethane, 0.487 g of 1-ethyl-3-(3-dimethyl-aminopropyl) carbodiimide hydrochloride and 0.0210 g of 4-(N,N-dimethylamino)pyridine, and this system was 10 subjected to a reaction at 25°C for 24 hours, thereby obtaining a reaction product at a yield of 30%.

As the result of the following elemental analysis and NMR measurement (solvent: deuterated chloroform), the resultant reaction product was identified as a carbazolyl 15 group containing isoleucine derivative (hereinafter also referred to as "Gelling Agent (3)"), in which n in the general formula (2) is 6.

Gelling Agent (3) had a melting point of 138°C.

[0052]

20 (Result of elemental analysis)

Calculated: C 78.25, H 10.54, N 6.37 %

Found: C 78.31, H 10.62, N 6.66 %

[0053]

(Result of NMR measurement)

25 CDCl<sub>3</sub>, δ 8.11-8.10 (d, J=8.0Hz, 2H), 7.48-7.39 (m, 4H), 7.24-7.21 (m, 2H), 6.02-6.00 (d, J=8.8Hz, 1H), 5.75 (m, 1H), 4.32-4.28 (t, J=7.2Hz, 2H), 4.17-4.13 (t, J=8.4Hz, 1H), 3.29-

3.26 (m, 1H), 3.19-3.15 (m, 1H), 2.17-2.13 (t,  $J=8.0\text{Hz}$ , 2H),  
1.89-1.86 (t,  $J=7.2\text{Hz}$ , 2H), 1.25 (m, 40H)

[0054]

(Confirmation of gel-forming ability of Gelling Agent  
5 (3))

With respect to Gelling Agent (3), the gel-forming ability for various organic solvents and liquid crystal compounds was investigated. As a result, Gelling Agent (3) exhibited good gel-forming ability for ethyl acetate,  
10 ethanol, methanol, acetone, carbon tetrachloride, benzene, toluene and N,N-dimethylformamide that are organic solvents and for 4-octyl-4'-cyanobiphenyl that is a liquid crystal compound.

[0055]

15 Gelling mixtures composed of Gelling Agent (3) and each of the organic solvents and liquid crystal compounds, for which Gelling Agent (3) exhibited the gel-forming ability, were observed through a scanning electron microscope respectively. As a result, it was confirmed  
20 that a fibrous molecular aggregate derived from Gelling Agent (3) having a network structure that fine and long fibers were entangled with each other is formed in an isotropic phase of each of the organic solvents and liquid crystal compounds forming the respective gelling  
25 mixtures.

[0056]

(Confirmation of properties of gelling mixture used

Gelling Agent (3))

The sol-gel transition temperature of a gelling mixture obtained by mixing 3 % by mass of Gelling Agent (3) with 4-octyl-4'-cyanobiphenyl, that is a liquid 5 crystal compound, was measured and found to be 40°C.

[0057]

A formed state of a fibrous molecular aggregate in a smectic A phase obtained by adding 0.5 % by mass of Gelling Agent (3) to 4-octyl-4'-cyanobiphenyl and 10 orientating it in one direction was observed through a scanning electron microscope and a polarizing microscope. As a result, it was confirmed that fibers grow predominantly in directions perpendicular and parallel to the orientation direction of the liquid crystal molecules.

15 [Example 4]

[0058]

(Synthesis Example 4 of gelling agent)

With 0.382 g of a compound, in which n in the raw carbazole derivative in the reaction scheme (2) is 1, 20 were mixed 0.651 g of a compound indicated as the raw isoleucine derivative in the reaction scheme (2), 31.0 g of dichloromethane, 0.496 g of 1-ethyl-3-(3-dimethyl-aminopropyl)carbodiimide hydrochloride and 0.0244 g of 4-(N,N-dimethylamino)pyridine, and this system was 25 subjected to a reaction at 25°C for 26 hours, thereby obtaining a reaction product at a yield of 78%.

As the result of the following elemental analysis

and NMR measurement (solvent: deuterated chloroform), the resultant reaction product was identified as a carbazolyl group containing isoleucine derivative (hereinafter also referred to as "Gelling Agent (4)" ), in which n in the 5 general formula (2) is 1.

Gelling Agent (4) had a melting point of 234°C.

[0059]

(Result of elemental analysis)

Calculated: C 77.37, H 10.08, N 7.12 %

10 Found: C 77.25, H 9.95, N 7.43 %

[0060]

(Result of NMR measurement)

CDCl<sub>3</sub>, δ 8.13-8.11 (d, J=7.6Hz, 2H), 7.49-7.46 (m, 4H), 7.36-7.28 (m, 2H), 5.89-5.86 (d, J=8.6Hz, 1H), 5.59 (m, 1H), 15 4.96 (s, 1H), 4.17-4.11 (t, J=7.2Hz, 2H), 3.15-3.06 (m, 2H), 1.70-1.65 (m, 2H), 1.39-1.25 (m, 32H), 0.90-0.85 (t, J=6.3Hz, 3H), 0.72-0.63 (m, 6H)

[0061]

(Confirmation of gel-forming ability of Gelling Agent 20 (4))

With respect to Gelling Agent (4), the gel-forming ability for various organic solvents and liquid crystal compounds was investigated. As a result, Gelling Agent (4) exhibited good gel-forming ability for ethyl acetate, 25 ethanol, chloroform, benzene, tetrahydrofuran and N,N-dimethylformamide that are organic solvents and for 4-pentyl-4'-cyanobiphenyl, 4-octyl-4'-cyanobiphenyl and 4-

octyloxy-4'-cyanobiphenyl that are liquid crystal compounds.

[0062]

Gelling mixtures composed of Gelling Agent (4) and 5 each of the organic solvents and liquid crystal compounds, for which Gelling Agent (4) exhibited the gel-forming ability, were observed through a scanning electron microscope respectively. As a result, it was confirmed that a fibrous molecular aggregate derived from Gelling 10 Agent (4) having a network structure that fine and long fibers were entangled with each other is formed in an isotropic phase of each of the organic solvents and liquid crystal compounds forming the respective gelling mixtures.

15 [0063]

(Confirmation of properties of gelling mixture using Gelling Agent (4))

The sol-gel transition temperature of a gelling mixture obtained by mixing 3 % by mass of Gelling Agent 20 (4) with 4-octyl-4'-cyanobiphenyl, that is a liquid crystal compound, was measured and found to be 106°C.

The sol-gel transition temperature of a gelling mixture obtained by mixing 3 % by mass of Gelling Agent (4) with 4-octyloxy-4'-cyanobiphenyl, that is a liquid 25 crystal compound, was measured and found to be 108°C.

[0064]

A formed state of a fibrous molecular aggregate in

a smectic A phase obtained by adding 0.2 % by mass of Gelling Agent (4) to 4-octyloxy-4'-cyanobiphenyl and orientating it in one direction was observed through a scanning electron microscope and a polarizing microscope.

5 As a result, it was confirmed that fibers grow predominantly in a direction perpendicular to the orientation direction of the liquid crystal molecules.

[Example 5]

[0065]

10 (Synthesis Example 5 of gelling agent)

With 0.232 g of a compound indicated as the raw carbazole derivative in the reaction scheme (3), were mixed 0.384 g of a compound indicated as the raw isoleucine derivative in the reaction scheme (3), 66.3 g 15 of dichloromethane, 0.491 g of 1-ethyl-3-(3-dimethyl-aminopropyl) carbodiimide hydrochloride and 0.0122 g of 4-(N,N-dimethylamino)pyridine, and this system was subjected to a reaction at 25°C for 27 hours, thereby obtaining a reaction product at a yield of 50%.

20 As the result of the following elemental analysis and NMR measurement (solvent: deuterated dimethyl sulfoxide), the resultant reaction product was identified as a carbazolyl group containing isoleucine derivative (hereinafter also referred to as "Gelling Agent (5)") 25 represented by the general formula (3).

Gelling Agent (5) had a melting point of 191°C.

[0066]

(Result of elemental analysis)

Calculated: C 75.33, H 9.82, N 6.94 %

Found: C 75.14, H 9.68, N 7.27 %

[0067]

5 (Result of NMR measurement)

CDCl<sub>3</sub>, δ 11.16 (s, 1H), 8.07 (m, 1H), 8.01-7.97 (t, J=7.2Hz, 2H),  
7.90-7.88 (d, J=8.0Hz, 1H), 7.43-7.41 (d, J=8.0Hz, 1H), 7.31-  
7.27 (t, J=6.8Hz, 1H), 7.13-7.09 (t, J=7.2Hz, 1H), 6.96 (s, 1H),  
6.82-6.80 (d, J=8.4Hz, 1H), 4.64 (s, 2H), 4.24-4.20 (m, 1H),  
10 3.12-3.08 (t, J=7.2Hz, 1H), 2.99-2.96 (t, J=7.2Hz, 1H),  
1.73 (m, 1H), 1.36 (m, 2H), 1.21 (m, 32H), 0.86-0.78 (m, 9H).

[0068]

(Confirmation of gel-forming ability of Gelling Agent  
(5))

15 With respect to Gelling Agent (5), the gel-forming  
ability for various organic solvents and liquid crystal  
compounds was investigated. As a result, Gelling Agent  
(5) exhibited good gel-forming ability for ethyl acetate,  
ethanol, acetone, chloroform, benzene and N,N-  
20 dimethylformamide that are organic solvents and for 4-  
pentyl-4'-cyanobiphenyl, 4-octyl-4'-cyanobiphenyl and 4-  
octyloxy-4'-cyanobiphenyl that are liquid crystal  
compounds.

[0069]

25 Gelling mixtures composed of Gelling Agent (5) and  
each of the organic solvents and liquid crystal compounds,  
for which Gelling Agent (5) exhibited the gel-forming

ability, were observed through a scanning electron microscope respectively. As a result, it was confirmed that a fibrous molecular aggregate derived from Gelling Agent (5) having a network structure that thick fibers 5 were entangled with each other is formed in an isotropic phase of each of the organic solvents and liquid crystal compounds forming the respective gelling mixtures.

[0070]

(Confirmation of properties of gelling mixture used  
10 Gelling Agent (5))

The sol-gel transition temperature of a gelling mixture obtained by mixing 3 % by mass of Gelling Agent (5) with 4-octyl-4'-cyanobiphenyl, that is a liquid crystal compound, was measured and found to be 65°C.

15 The sol-gel transition temperature of a gelling mixture obtained by mixing 3 % by mass of Gelling Agent (5) with 4-octyloxy-4'-cyanobiphenyl, that is a liquid crystal compound, was measured and found to be 67°C.

[0071]

20 From the results described above, it was confirmed that the gelling agents according to Examples 1 to 5 have a molecular structure that a carbazole component has been introduced into an isoleucine derivative, and have good gel-forming ability for organic solvents or liquid 25 crystal compounds.

It was also confirmed that the gelling mixtures respectively containing the gelling agents according to

Examples 1 and 3 to 5 in particular have a possibility of being suitably usable as liquid crystal display devices.

[0072]

It was further confirmed from the gelling agents according to Examples 1 and 2 that the carbazolyl group containing isoleucine derivative (1) constituting each gelling agent has a lower melting point as  $m$  in the general formula (1) becomes greater, and a gelling mixture obtained by mixing a gelling agent composed of the carbazolyl group containing isoleucine derivative (1) has a lower gel-sol transition temperature as the melting point of the carbazolyl group containing isoleucine derivative (1) that is a component of the mixture becomes lower.

It was still further confirmed from the gelling agents according to Examples 3 and 4 that the carbazolyl group containing isoleucine derivative (2) constituting each gelling agent has a lower melting point as  $n$  in the general formula (2) becomes greater, and a gelling mixture obtained by mixing a gelling agent composed of the carbazolyl group containing isoleucine derivative (2) has a lower gel-sol transition temperature as the melting point of the carbazolyl group containing isoleucine derivative (2) that is a component of the mixture becomes lower.

[Industrial Applicability]

[0073]

The gelling agents according to the present invention may be suitably used as materials forming physical gel, and the gelling mixtures respectively using the gelling agents have a possibility of being suitably 5 usable as liquid crystal display devices.

[Brief Description of the Drawing]

[0074]

[Figure 1]

It is a figure illustrating an ultraviolet-visible 10 absorption spectrum of a gelling mixture according to Example 1.